

Docket No. 8543-004-27 (761P7)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF: LIAO ET AL

JUN 30 2000

GAU: 2814

SERIAL NO: 08/825,360

EXAMINER: TUAN QUACH

FILING DATE: MARCH 28, 1997

FOR: INTERCONNECT STRUCTURE FOR USE IN AN INTEGRATED CIRCUIT

REQUEST FOR RECONSIDERATION

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Responsive to the outstanding Office Action issued December 30, 1999 in the above-captioned patent application, the time for response thereto being extended by virtue of the petition and extension fee submitted herewith, withdrawal of the rejections of all claims pending as anticipated or obvious, 35 U.S.C. §102/103, is respectfully requested, in light of the comments set forth below.

Applicants' invention resides in the discovery that electrical interconnects through "contact holes" or "via holes" can be made effectively, even in structures having dimensions below 0.3 microns in width, while maintaining an acceptable resistance of approximately 3 Ω . To this end, Applicants' invention resides in the formation of a first layer of refractory metal on the underlying conductive surface, and the inner walls of a channel extending through material above the conductive surface, generally a dielectric. The material selected to form this first layer is one that has good conductive properties when reacting with the underlying conductive material, which will be interconnected to another conductive layer at the opposite end of the contact or via hole. See, e.g., page 11, line 24-page 12, line 4 of the specification as filed. Thereover, a second layer, specifically a metal nitride layer, is deposited. Metal nitrides are

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selected so that an adhesive conductive contact with the conductive, metal component of the interconnect structure is formed therebetween. See, page 12, lines 5-15. Additionally, the metal nitride is selected so as to have a thickness of less than 130 Å. This thickness is of patentable dimension, in that in confining the metal nitride overlayer to a thickness less than 130 Å, preferably 25-75 Å, Applicants provide sufficient thickness for the conductive layer to form the interconnect and preserve resistance values at acceptable levels. See, Table A, page 40. This invention is nowhere taught in the art.

A Power of Attorney accompanies this request.

REJECTION OVER U.S. PATENT 5,714,418, BAI

Claims 21-23 and 40-45 stand rejected as anticipated or obvious, 35 U.S.C. §102(e), over Bai, et al. This rejection is maintained from the prior Office Action. Applicants have antedated this reference by reliance on a Declaration pursuant to 37 C.F.R. §1.131. The Examiner has not indicated that the Declaration is insufficient to establish an earlier invention date, rather, the Examiner persists in the rejection on the ground that Bai claims the same invention as claimed herein, and entitlement can only be resolved by an interference.

Applicants respectfully submit that the Examiner's declination to accept the Declaration is at odds with the grounds for rejection. If, in fact, the Examiner was of the opinion that Bai had disclosed and claimed Applicants invention, the proper grounds for rejection would be under 35 U.S.C. §102(g). No such rejection has been made. Moreover, in determining whether claims of an application interfere with claims of a patent, only the claims may be considered. 37 C.F.R. §1.601(n). Additionally, an interference can only be contested where the claims of the patent render the claims of the application obvious, as well as the application rendering the claims of the

patent obvious. Obviousness is now a two-way test. Fujita v. Winter. Comparing Claim 1 of Bai with Claim 21 of the pending application, it is clear that while Claim 21 of Applicants may suggest a sub-genus which anticipates Claim 1 of Bai, nothing in Bai suggests Applicants independent claim, in fact, Bai fails to suggest a nitride layer at all, or any outer protective layer that forms an adhesive conductive contact with the metal component of the interconnect. Indeed, while in fact, certain dependent claims of Bai, such as Claim 13, recite a Markush group of various metals which may be employed, which inadvertently include one or two nitrides, it is clear that the Markush group itself is insufficient to specifically teach the claimed invention. Accordingly, the Examiner's suggestion for an interference is respectfully submitted to be unsupported by the necessary rejection, and inappropriate given the lack of a two-way obviousness situation.

Further Applicants note that in determining whether there is basis for an interference, the comparison must be between the claims alone, not the specification. The Examiner relies heavily on portions of the specification of Bai, which may not be relied on to determine the propriety of an interference. Again, Applicants note that while they have demonstrated their entitlement to an interference, if one is appropriate, the Examiner has failed to lay either the appropriate procedural frame work, including rejection under 35 U.S.C. §102(g), and the necessary substance, a comparison between the claims, showing two-way obviousness, to precipitate such an interference.

Accordingly, again, the rejection over Bai is respectfully traversed.

REJECTION OF BAI IN VIEW OF SECONDARY ART

The Examiner further rejects Claims 24-31, 48-50, 52 and 53 as obvious over Bai, taken in view of Ho et al., Hower et al. and Fu et al. As noted above, Applicants have antedated Bai

via a 131 Declaration. Nowhere in the outstanding Office Action is the Examiner critical of that Declaration, nor does the Examiner find it wanting in any way. According, as Bai is not applicable as prior art, the rejection cannot be sustained. Accordingly, withdrawal of this rejection is respectfully requested.

REJECTION OVER BAI IN VIEW OF U.S. PATENT 4,960,732, DIXIT

The Examiner further rejects that Claims 46 and 47, which specify tungsten as the metal component of the interconnect as obvious over U.S. Patent 4,960,732, Dixit et al. (Dixit). For the reasons set forth above, Applicants have antedated by as a reference, and clearly, in this context, Bai as not being used as reference under 35 U.S.C. §102(g). Accordingly, withdrawal of this rejection is respectfully requested.

REJECTION OVER DIXIT OR U.S. PATENT 5,723,382, SANDHU WITH SUGURO

On page 6 of the outstanding Office Action, the Examiner rejects Claims 21-23 and 40-47 as obvious over Dixit or U.S. Patent 5,723,382, Sandhu et al. (Sandhu) as alternative primary references, either taken in view of the article in Applied Surface Science by Suguro, et al. (Suguro) attached to the outstanding Office Action. Initially, Applicants note that Suguro does not appear to be of record on a form 1449 initialed by the Examiner, and Applicants respectfully request such a form be issued. Further, the rejection is respectfully traversed.

Turning first to Dixit as a primary reference, Applicants respectfully submit that Dixit teaches precisely away from the claims herein. Dixit specifically teaches that the TiN layer employed therein must be a minimum 250 Å, and teaches that it may range up to 2,000 Å in thickness. Indeed, Dixit specifically teaches away from attempting to form a layer thinner than

about 250 Å.

It is difficult to form a pin hole-free barrier with thicknesses less than about 250 Å and employing thicknesses greater than about 2,000 Å provides little additional protection.

Dixit, column 4, line 61-64. Where the principal reference teaches directly away from a principal recitation of the claims presented, the rejection must fail for obviousness. The specification makes it clear that the limitation of a thickness of less than 130 Å for the nitride layer is essential in retaining low resistance properties, even in geographies or topographies of less than 0.25 microns. Applicants respectfully submit that no matter what the teaching of a secondary reference, no rejection for obviousness can be based on a primary reference such as Dixit, which teaches directly away from a principal aspect of the claims. It is clear that Dixit does not teach "thickness optimization" relied upon by the Examiner, page 7.

Turning to Sandhu, it is clear that Sandhu is equally incapable of leading one of ordinary skill in the art to the claimed invention. Indeed, while Applicants agree that Sandhu refers to the deposition of titanium nitride as one alternative interposed between a layer of titanium silicide and tungsten or other conductive material, Applicants respectfully submit that the reference is absolutely silent as to the thickness of this layer. Indeed, the only reference to thickness of this layer in the entirety of the Sandhu disclosure is that which appears at column 5, lines 51-54, referring to "the characteristic thinness of barrier layers used in integrated circuit manufacture." Applicants have acknowledged the prior existence of barrier layers. Characteristic thicknesses are recited in the application.

Traditionally, the thickness of barrier layers has remained at 400-500 Å, even in integrated circuits with reduced dimensions.

Pending application, page 6, lines 14-16 as originally filed. Thus, Sandhu, like Dixit, teaches one

of skill in the art to use thicknesses well in excess of Applicants claimed maximum.

The Examiner's reliance on Suguro to cure these defects is unavailing. Initially, it is noted that it is well established in the law that reliance on a secondary reference to change the teaching of the primary reference, at a point of novelty, is contrary to the law, and necessarily based on hindsight. Nonetheless, even considered on its merits, the marriage of Suguro to either primary reference relied on by the Examiner fails to teach the claimed invention. Specifically, Suguro is not looking at interconnect structure, and is not worried about preventing conductive atom penetration. The Suguro reference is directed to analytical study of the rate of penetration of silicon atoms in a TiN/Si system, and no actual structure is prepared. In contrast, the claimed invention, as well as Dixit and Sandhu, are directed at preparing layers that prevent penetration and poisoning of the conductive material into the silicon, not the other way around. One of skill in the art reading Suguro, would learn little that would direct him to change the teaching of the primary references. Moreover, Suguro teaches a minimum value only, and does not address practical difficulties, such as the pin hole problem identified in Dixit. One of skill in the art, comfortable that the silicide penetration value of the minimum TiN layer of Dixit or Sandhu would be sufficient, given Suguro, to prevent penetration and to provide the necessary physical stability, one would adopt the minimum levels of the principal references. This rejection is according respectfully traversed.

Further, Applicants note the Claims 22 and 21 have been treated identically, above. Similarly, Claim 23 as been treated together with Claims 21 and 22. This should not be considered a concession that the claims are not patentably distinct. In particular, Claim 22 identifies a range of thickness for the metal nitride layer of 25 to 75 Å. Even if the Examiner's characterization is correct, teaching a blocking layer having a thickness of "between 10 Å and

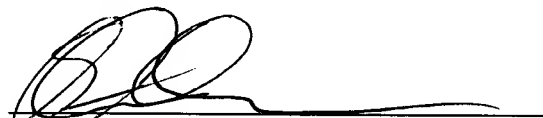
500 Å", page 3, which Applicants dispute, Bai fails to teach the central highlighted layer thickness, which has been demonstrated to have unobvious characteristics in terms of the resistance, coupled with barrier layer function, set forth in the specification as originally filed. The identification of a narrow subset within a broad range, coupled with the identification of unexpected properties observed within that narrow range, is a fundamental demonstration of unobviousness. In re Waymouth. Accordingly, withdrawal of the rejections of these specific claims is further warranted, and the same respectfully requested.

SUMMARY

Applicants respectfully submit that by the Examiner's own characterization of the rejection and Office Action, and the Examiner's reliance on the disclosure of Bai, as opposed to its' claims, there is no grounds for pursuing an interference between Applicants' claims and Bai. Bai is otherwise not applicable as a reference, having been antedated pursuant to 37 C.F.R. §1.131. As discussed above, the claims presented are patentably defined over the remaining references, and allowance is respectfully requested.

Respectfully submitted,

PIPER MARBURY RUDNICK & WOLFE LLP



Steven B. Kelber
Registration No: 30,073
Attorney of Record

1200 Nineteenth Street, N.W.
Washington, D.C. 20036-2412
Telephone No. (202) 861-3900
Facsimile No. (202) 223-2085